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COMMERCIALIZATION OF NESSUS - STATUS

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In 1988, Southwest Research Institute initiated a plan to commercialize the NESSUS probabilistic structural analysis software. The goal of the on-going commercialization effort is to begin the transfer of PSAM developed technology into industry and to develop additional funding resources in the general area of structural reliability. Initially, this goal will be met through code license support. This paper reports on the status of the on-going NESSUS commercialization effort at SwRI.

The SwRI/NESSUS[™] Software System is a general purpose probabilistic finite element computer program employing state-of-the-art methods for predicting stochastic structural response due to random loads, material properties, part geometry, and boundary conditions. NESSUS can be used to assess structural reliability, to compute probability of failure, to rank the input random variables by importance, and to provide a more cost-effective design than traditional deterministic methods.

NESSUS continues to be developed by Southwest Research Institute (SwRI) for the National Aeronautics and Space Administration under the Probabilistic Structural Analysis Methods (PSAM) contract NAS3-24389 (1985-1989, 1990-1994). The goal is to develop a general probabilistic structural analysis methodology to assist in the certification of critical components in the next generation space shuttle main engine.

Near the end of the first five-year PSAM effort, discussions with numerous firms indicated that there was an interest in applying the NESSUS computer program to design concerns that were believed to be significantly affected by random, or uncertain, variables. This, in combination with our belief that reliability based design and certification by analysis is a promising new technology area led to our decision to promote the application of NESSUS on a commercial basis.

Some Aspects of the Commercialization Effort

The NESSUS code was developed as a research code with attention given to the development of capabilities specifically required for the PSAM program, including a reasonable user interface. To support commercial interests in this technology, we are implementing new capabilities and expanding existing capabilities in NESSUS to take the code from a purely research environment to a design application environment. To date, nearly all of the SwRI developed enhancements have been implemented in the NASA version of NESSUS.

The NESSUS Software System is developed on a network of Apollo Workstations running the Domain/SR10.2 operating system. A Configuration Management (CM) system has been implemented in order to track incremental versions, provide automated source code change tracking, and provide a means for re-constructing past versions of the NESSUS code. A family of specially tailored shell scripts have been developed and are used to manage the CM system.

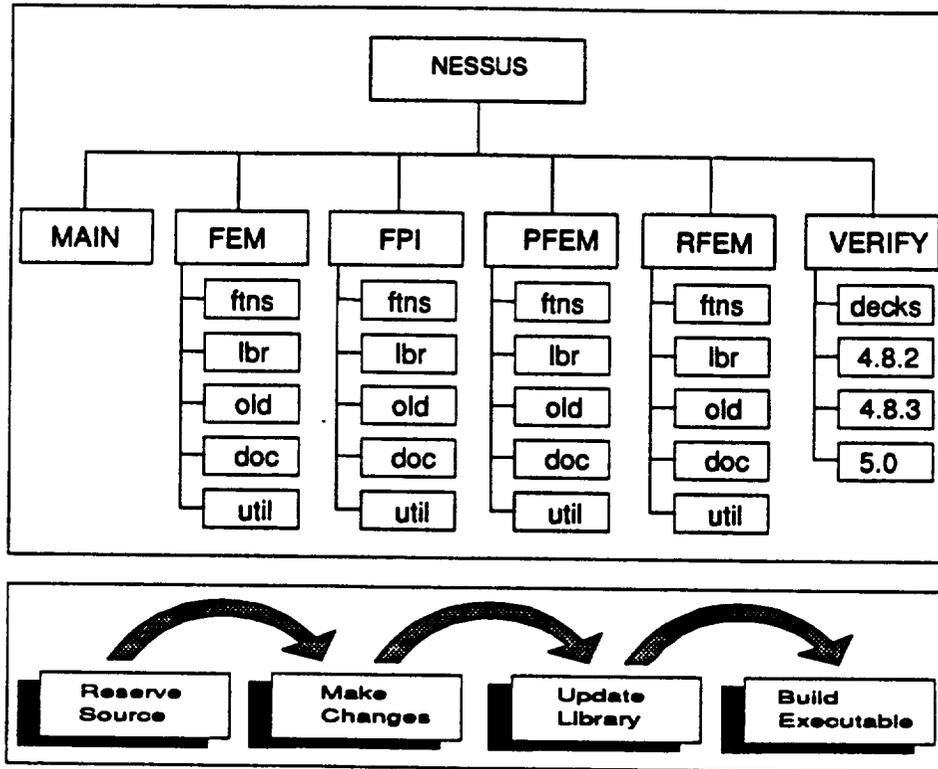
All of the existing NESSUS documentation has been improved and several new manuals written. The existing manuals (NESSUS/FEM, FPI, and PRE User's Manuals) were reviewed for errors and cleaned-up. Several new manuals were developed: NESSUS Demonstration Manual, VAX/Cray/Apollo/Sun Installation Guides, NESSUS/FEM Systems Manual, and the P/NESSUS Users Manual. The demonstration manual contains a detailed tutorial for performing a probabilistic analysis with NESSUS, NESSUS/FEM validation problems, and NESSUS/PFEM probabilistic validation problems. The NESSUS/FEM Systems manual, primarily for SwRI use, serves as a programmers/developers guide. The installation manuals explain how to install and execute NESSUS on the different computer systems, compile and link in user-programmed subroutines, and run a set of validation problems to check the installation.

Graphical pre- and post-processing capabilities for NESSUS are provided by P/NESSUS. P/NESSUS is designed to be used in conjunction with the commercially available PATRAN¹ software and provides for a data exchange process between NESSUS and PATRAN. Specific options are available in P/NESSUS to translate (1) a PATRAN finite element model to a NESSUS input deck, (2) a NESSUS input deck to a PATRAN finite element model, (3) a NESSUS post file to a PATRAN finite element model, and (4) a NESSUS perturbation data base to PATRAN results files. In (4), deterministic and perturbed solution data is translated for incremental, modal and harmonic analysis types.

SwRI is currently working with several clients interested in applying NESSUS to specific design problems. Future work that has been identified by industry as important include better input and output organization, graphics capabilities, better documentation, more extensive FEM modeling capabilities, and interfacing to third party commercial FE codes.

1 PATRAN is a registered trademark of PDA Engineering

NESSUS CONFIGURATION MANAGEMENT SYSTEM



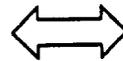
EXTENDED DOCUMENTATION DEVELOPED

- Software QA Plan Developed
 - Controls for Software Development and Validation
- P/NESSUS Graphics Translator
- Promotional Flyer
- Logo
- Documentation
 - NESSUS Demonstration Manual
 - VAX/CRAY/Apollo/Sun Installation Guides
 - NESSUS/FEM Systems Manual
 - P/NESSUS Users Manual

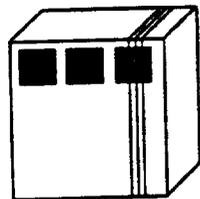
P/NESSUS Links PATRAN and NESSUS

PATRAN Geometry to/from NESSUS

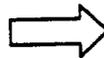
Coordinates
Elements
Boundary Conditions
Material Properties
Loads/Pressures/Temperatures



Graphic Workstation
Running PATRAN



Compute Server
Running NESSUS



NESSUS Results to PATRAN

Stresses/Strains
Displacements
Incremental/Modal/Spectral
Deterministic/Perturbed

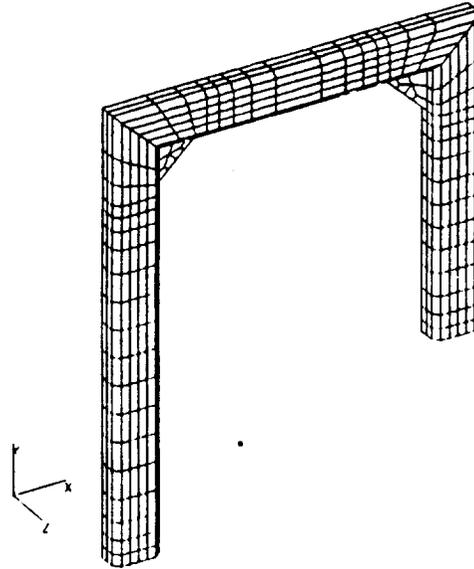


SOFTWARE ENHANCEMENTS

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- NESSUS/FPI Extended User Interface
 - All Output Re-written to be Better Organized
 - All Input Keyword Driven with Column Independent Data Input
 - PATRAN Graphics Interface (P/NESSUS) Developed
 - Probabilistic Storage File Being Developed to Store Probabilistic Information
 - PFEM Output Organization

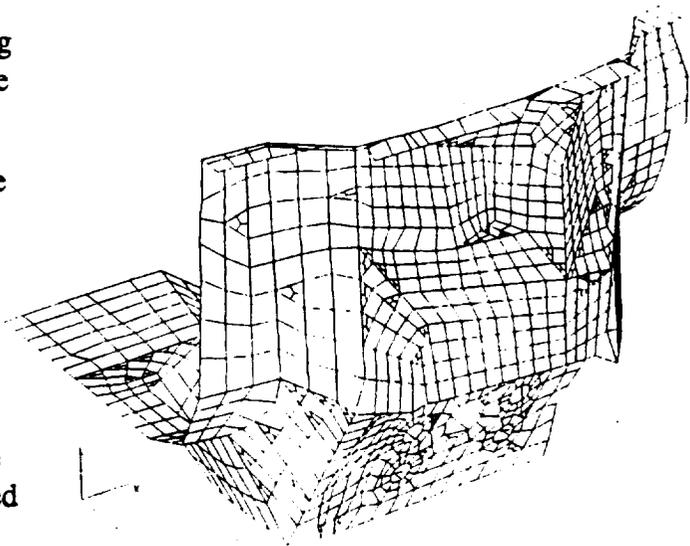
APPLICATIONS - Probabilistic Analysis of a Roll Over Protection System (ROPS)

- ROPS Certified by Meeting Strict SAE Legal Criteria on Deflection Envelop
- All Heavy Earthmoving Equipment Must Meet Criteria
- NESSUS Used to Determine the Probability of Exceeding Design Envelop for Deflections



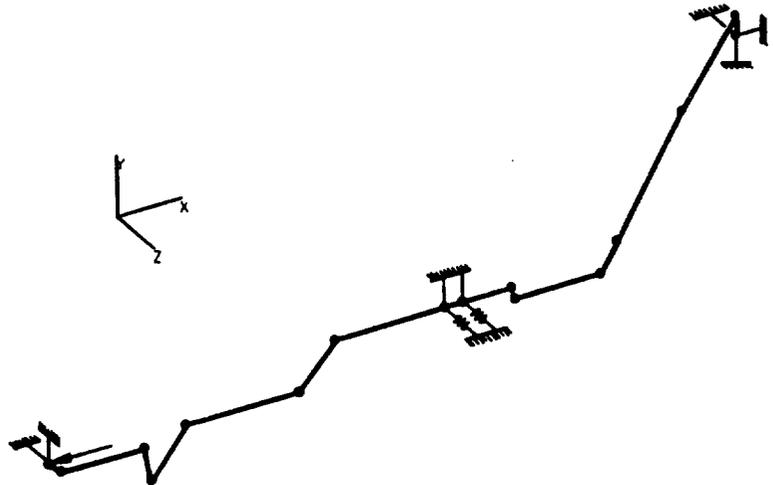
APPLICATIONS - Automobile Shock Tower Analysis

- Shock Tower Structure Carries Loading from Shock Absorption System into the Main Automobile Frame
- Durability Requirements Set Due to the Dynamic (Random) Nature of the Loading
- NESSUS was used to Compute the Probability of Not Meeting a Required Design Life (Unreliability)
- Random Variables that Contributed the Most to the Unreliability were Identified and Suggestions for Redesign Made



APPLICATIONS - Automobile Door Latch Mechanism

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- Mechanism Studied Serves as a Key Connecting Rod in the Automobile Door Latching System
 - Door Latch Mechanism Required to Operate Within Certain Deformation and Force Constraints
 - Using a Simple Beam Model, NESSUS Predicts the Variation in Deformation and Force Responses Due to Variations in Material Properties and Connecting Clip Spring Stiffness
 - Several Variables Identified that Contributed the Most to the Variation in Deflections and Clip Forces



NESSUS Commercialization Benefits PSAM

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- Mutual Sharing of Developed Technology
 - Better Support for NASA Engineers
 - More Robust User Interface and Documentation
 - Technology Transfer into Other Industries Helps to Identify and Strengthen Code Weaknesses
 - Visibility - Projects Good Image of NASA's Foresight in Developing Probabilistic Structural Analysis Methods